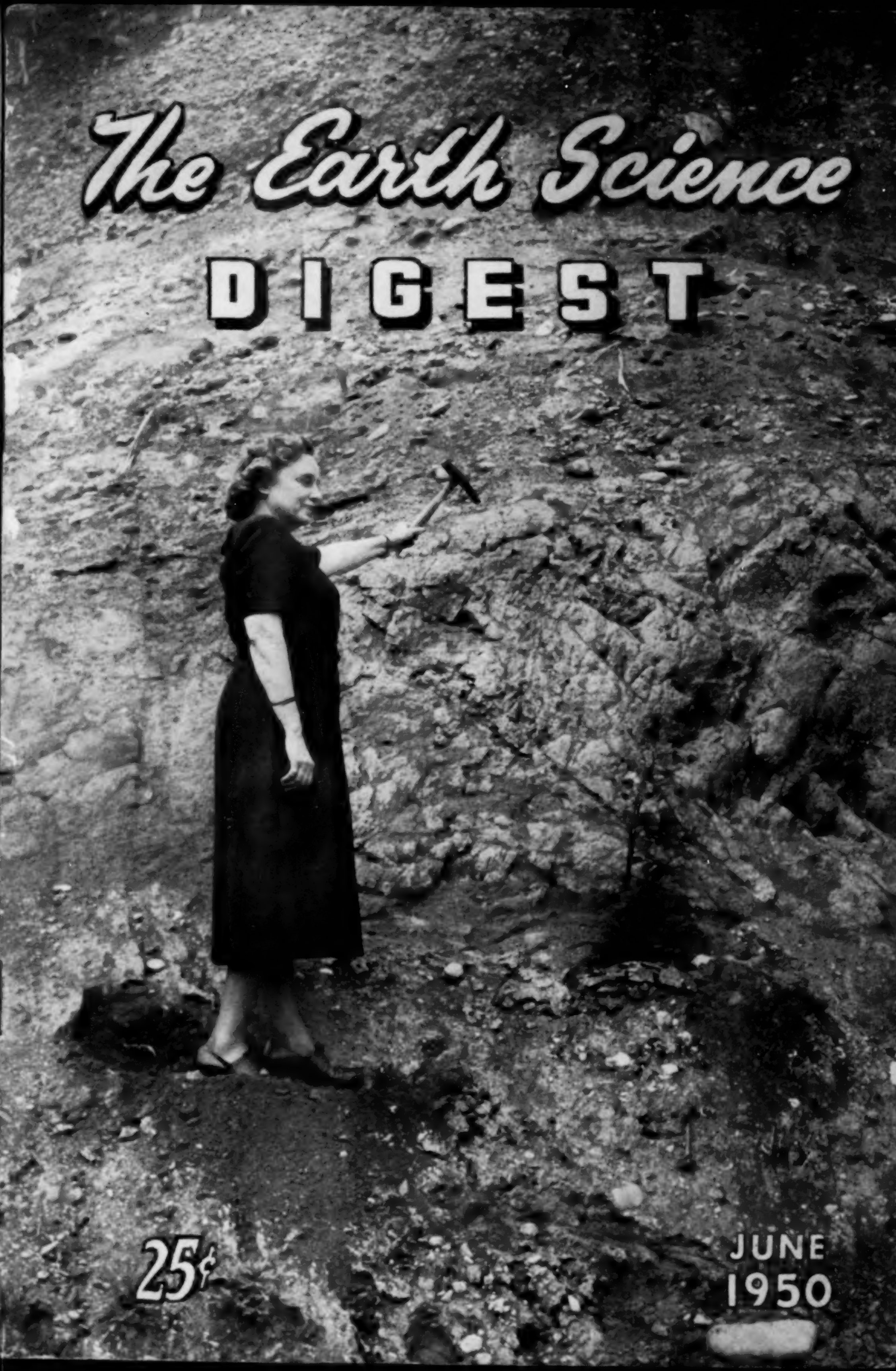
The Earth Science DIGEST



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JUNE 1950

THE EARTH SCIENCE INSTITUTE

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S. ALBERT EISENBERG,
JEROME M. EISENBERG, Publishers
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- Northwest Federation of Mineralogical Societies, Annual Convention.

September 2-3, 1950. State Armory, Spokane, Wash.

- Geological Association of Canada, Annual Meeting. Sept. 11, 1950. Banff, Alberta.
- National Petroleum Association, Annual Meeting, Sept. 13-15. Hotel Traymore, Atlantic City, N. J.

$18,000 Bequest Granted To University of Minnesota Geology Department

The department of geology of the University of Minnesota has been granted a bequest in the amount of approximately $18,000 from the estate of Mr. Junior Hayden, a Minneapolis business man who was an ardent naturalist, amateur photographer, and geologist. Mr. Hayden was a charter member of the Minnesota Geological Society, an organization with a membership of approximately 200 enthusiastic non-professional geologists.

During the past two years Mr. Hayden contributed nearly two thousand Kodachrome slides of geologic subjects to the department of geology at the University. The photographs represent a wide and intelligent selection of subject matter from the National Parks and Monuments of the western states and from numerous mining camps and iron ranges. The additional, generous cash bequest will be used mainly to promote general education in the earth sciences.

Colorful Map of Denver Mountain Area Issued

WASHINGTON, May 23 — Publication of a new map of the Denver Mountain Area, another in the U. S. Geological Survey's special series of shaded relief maps, was announced today by Secretary of the Interior Oscar L. Chapman.

This area includes one of the nation's most popular winter and summer playgrounds. Discovery of gold in the mountains near Denver was probably more responsible for the influx of settlers during the period 1857-1867 than any other single feature. Denver, Boulder, Central City, Idaho Springs, and Fort Collins all sprang up within those 10 years. All are shown on the map together with several other large towns which grew up in the decade that followed.

The shading on this map, printed over brown contour lines spaced at 500 foot intervals, brings out relief in the mountainous portions in striking fashion. Just to the left of the map's center the Continental Divide can be traced.

This new map includes the heart of the State of Colorado, from Denver north to within about 18 miles of the Wyoming border, an area in which more than 60 percent of the state's population is concentrated.

Here, too, are portrayed the topographic features of the Bureau of Reclamation's Colorado-Big Thompson Project for diverting water from the Upper Colorado River Basin on the western slope of the Divide to the eastern.

On the reverse side of the map is printed a wealth of textual material on the Denver Mountain Area, its setting and its geologic history including a graphic description of how the mountains were formed and what happened during the Ice Age in Colorado.

Cover Photo

In this month's cover photo, Mrs. Martha Carr, geologist with the U. S. Geological Survey and author of this month's feature article, points out "the Great Unconformity." Between the rocks shown below the hammer and the upper layers of gravel is a line which marks a gap of some 365 million years in Washington's geologic past. During that long interval the very ancient mountains once present were gradually worn down through natural processes of erosion until there remained only an upland plain. Photo courtesy of the U. S. Geological Survey.

THE GEOLOGIC HISTORY OF THE DISTRICT OF COLUMBIA

MARTHA S. CARR
U. S. GEOLOGICAL SURVEY

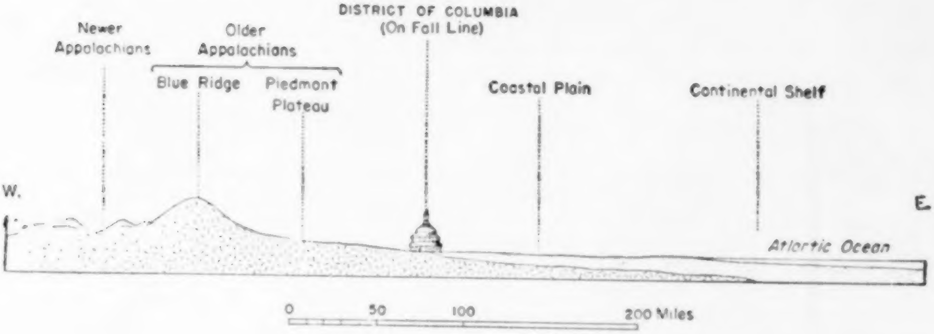

Fig. 1 — Cross section showing the location of the District of Columbia in relation to the physiographic provinces of the eastern United States. Modified after A. K. Lobeck, from U. S. Geological Survey Bulletin 967.

The District of Columbia covers an area of about 70 square miles on the northeast side of the Potomac River, adjacent to the mouth of the Anacostia River. Through it passes the Fall Line, the boundary between the Piedmont province and the Coastal Plain province. The altitude of the area ranges from sea level along the river flats to about 420 feet at Reno Reservoir in the northwestern part. The mean altitude is abut 150 feet.

The oldest rocks of this region were formed in remote pre-Cambrian time, when the gradual cooling of the earth's molten mass produced the ancient granites. Later, natural forces within the earth caused these igneous rocks to be pushed up, bent, squeezed, and broken, and through the breaks came the magmas of other igneous rocks — diorite and the younger granites. Some of the igneous rocks themselves have been subjected to such intense pressure and heat far underground that they have become metamorphic rocks. The resulting structure is very complex.

No record has been preserved of geologic events in the District of Columbia during the millions of years of the Paleozoic era and the Triassic and Jurassic periods of the Mesozoic era. During that long interval the very ancient mountains once present were gradually worn down through the natural processes of erosion until there remained only an upland plain. At the end of the Jurassic

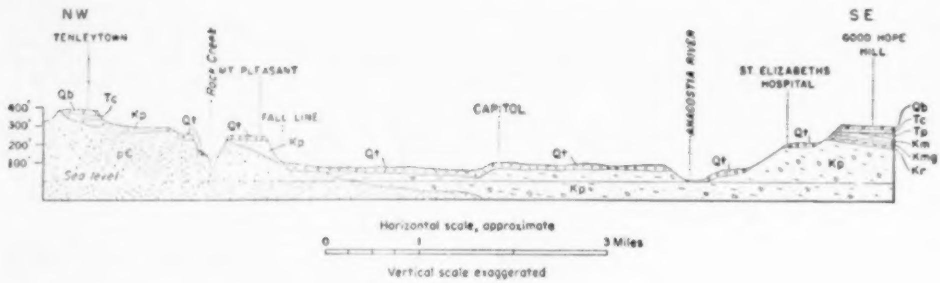

Fig. 2 — Generalized geologic section across the Washington area, showing the relation of the crystalline rocks of the Piedmont province to the overlying sedimentary formations of the Coastal Plain province, and the arrangement of the terraces. After N. H. Darton, from U. S. Geological Survey Bulletin 967.

Qt—River terrace deposits (Pleistocene); gravel, sand, loam, unsorted boulders, and pebbles.

Qb—Brandywine formation and Bryn Mawr (?) gravel (Pleistocene and Pliocene?); gravel and sand in orange loam matrix.

Tc—Calvert formation of the Chesapeake group (Miocene); gray or buff to olive green sandy clay, marl, diatomaceous earth.

Tp—Pamunkey group (Eocene), which includes the Marlboro clay member of the Nanjemoy formation and the Aquia formation; pink clay, dark sandy clay, greensand, marl, and gray to brown sand with ironstone layers.

Km—Monmouth formation (Upper Cretaceous); dark micaceous sand, generally glauconitic, shell marl, and brown sand with ironstone layers.

Kmg—Magothy formation (Upper Cretaceus); sand, sandstone, and conglomerate.

Kr—Raritan formation (Upper Cretaceous); clay, chiefly red or pink, and sand.

Kp—Potomac group (Lower Cretaceous) clay, chiefly pink, red, and gray, sand, gravel, sandstone, and conglomerate.

pC—pre-Cambrian igneous and metamorphic rocks; granite, gneiss, schist, diorite, soapstone, and other rocks.

period this plain was tilted down to the southeast. Today, the higher parts of the old plain, the Piedmont Plateau, are rolling hills mantled with soils derived from the decaying rocks. The northwestern third of the District of Columbia is a part of the Piedmont Plateau.

In the southeastern part of the District the sloping floor of old crystalline rocks is covered by the unconsolidated Coastal Plain deposits. The oldest of these beds, those of the Potomac group, are composed of gravel, sand, and clay, and lagoons. Following the Lower Cretaceous epoch, the region was subjected to repeated elevations and subsidences. During periods of elevation the land was eroded; in periods of subsidence, deposits of gravel, sand, and clay washed down from higher areas on the west were laid down in the waters. These deposits, like the Potomac group, are wedge-shaped, thickening toward the southeast. In order from oldest to youngest they include the Raritan, Magothy, and Monmouth formations of the Upper Cretaceous epoch; the Aquia and Nanjemoy formations of the Eocene epoch; and the Calvert formation of the Miocene epoch.

During widespread uplift in the later part of the Tertiary period and the early part of the Quaternary period of the Cenozoic era,

Fig. 3 — Silicified logs found in deposits of the Potomac group (Lower Cretaceous) near Fourmile Run, Va. Photo by courtesy of The Evening Star, Washington, D. C., from U. S. Geological Survey Bulletin 967.

the cutting power of the streams of the region was increased. Then as their carrying power gradually lessened with the wearing down of the land, their loads of sand and gravel were spread over the eroded surface of the Piedmont and the inland margin of the Coastal Plain beds. These old river deposits, the Brandywine formation and the Bryn Mawr (?) gravel (Pleistocene and Pliocene?) once covered the entire region but now are seen in the District of Columbia only on upland remnants. The ridges that extend from American University and Mount Alto Hospital northward to Reno Reservoir, the high land on which Soldiers' Home is located, and Good Hope Hill are parts of this old upland plain, or so-called Lafayette Plateau.

In Pleistocene time, when the glaciers on the northern part of the continent were melting, the Potomac Basin was subjected to recurrent floods. Then as the region gradually rose, the shifting waters of the old rivers carved terraces in the rocks, especially in the soft Coastal Plain beds, and

Fig. 4—A large dinosaur bone discovered in the excavation of the deposits of the Potomac group (Lower Cretaceous) at the McMillan Filter Plant. This specimen is the lower end of the femur, the long bone from the hip to the knee. From the uppermost end of the bone, where it has been fractured, to its base, it measured 11½ inches. The longest measurement across the knee bone is also 11½ inches. U. S. Geological Survey photo.

deposited on the terraces new sheets of gravel, sand, and clay. The main part of the city is built on these terraces.

The earliest life of which any evidence has been found in the District of Columbia existed about 100 million years ago during early Cretaceous time. Animal life of that epoch included fresh-water mollusks, turtles, crocodiles, and huge dinosaurs; among the plants were ferns, sequoia, water-lily, and grape. Fossil remains from later deposits include various mollusks, shark teeth, and leaves of the oak, elm, sumac, holly, and blueberry.

Of the mineral resources of the District of Columbia, stone has had a leading part. Gneiss and granite quarried near Rock Creek and on the banks of the Potomac above Georgetown were used in early buildings and still are employed to some degree. The extensive deposits of gravel, sand, and clay of the Coastal Plain have long been used in the manufacture of brick and terra-cotta tile and in road building. Also present in or near the District are iron ore and diatomaceous earth in the Coastal Plain area and manganese, mica, feldspar, and gold in the Piedmont area, but attempts made at various times to develop these have not been very successful, generally because of relatively low quantity or quality.

[Reprinted in part from U. S. Geological Survey Bulletin 967, "The District of Columbia — Its Rocks and Their Geologic History", by Martha S. Carr (Washington, D. C., 1950].

Teeth Give Clue To Man's Ancestors

BIRMINGHAM, Eng., May 19 (Science Service)—Getting teeth into the question of whether modern man had ancestors or cousins in South Africa thousands of years ago, Dr. S. Zuckerman, anatomist of the Birmingham University Medical School here, finds that the teeth of the South African fossil ape men resemble those of two human types far less than they do those of existing apes.

The large-toothed Australian aboriginals and the medium to small-toothed ancient Egyptians are less like the ancient Australopithecus fossils from South Africa than the teeth of the orang and gorilla.

Earth Science Abstracts

[Selected articles on the earth sciences, appearing in current scientific publications, are abstracted here for the convenience of our readers.]

A SURVEY OF GEOPHYSICS. Friedrich Gassmann. **Scientific Monthly**, Vol. 70, No. 6 (June 1950), pp. 358-364. There are three chief parts of geophysics: the physics of the solid part of the earth; oceanography; and the physics of the atmosphere. The physics of the solid part of the earth is further subdivided into the physics of the solid earth as a whole; of the outermost shell; of the earth's crust, of the subsoil; and of the soil. Among the topics surveyed are the interior of the earth, gravity, terrestrial magnetism, earthquakes and applied seismology, and geoelectricity.

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DESCRIPTION AND SYNTHESIS OF THE SELENIDE MINERALS. J. W. Earley. **Am. Mineral.**, Vol. 35, Nos 5-6 (May-June 1950), pp. 337-364. Revised descriptions of the selenide minerals include some new measurements of specific gravity, new unit cell dimensions, together with X-ray powder data for all the species and reproductions of the patterns. Naumannite, aguilarite, eucairite, crookesite, berzelianite, umangite, clausthalite, tiemannite, klockmannite, penroseite, guanajuatite, and paraguanajuatite are described.

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STRATIGRAPHY AND THE STUDY OF METAMORPHIC ROCKS. Marland P. Billings. **Geol. Soc. Am. Bull.**, Vol. 61, No. 5 (May 1950), pp. 435-448. "In recent years many students of metamorphic rocks have become so preoccupied with minor structures, structural petrology, physical chemistry, and granitization that the stratigraphy of metamorphic rocks has been neglected. There is great danger that the younger men, indoctrinated with the idea that stratigraphy and sedimentation are unrelated to metamorphic geology, will be inadequately trained to study metamorphic rocks in the field. Geologic maps of regions characterized by different grades of metamorphism should be based on stratigraphy. The assignment of the rocks to formations should be based on the inferred lithology prior to metamorphism and should not be based directly on the present lithology. The student of metamorphic rocks should be familiar with modern concepts of stratigraphy and sedimentation, such as deposition in transgressing and regressing seas, changes in sedimentary facies, and time surfaces. Metamorphic geologists should be familiar with the textures, mineralogy, and chemical composition of sedimentary rocks. When sufficiently large areas are studied, the metamorphic geologist should think in terms of the paleogeography and climate conditions at the time of sedimentation. Stratigraphers and students of historical geology should realize that their concepts of paleogeography will be incorrect if they neglect the wealth of data to be obtained from metamorphic rocks. Thee facts can be abstracted from the metamorphic rocks only by intensive investigations in the field by a host of metamorphic geologists well-trained in stratigraphy."

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TECTONIC THEORY VIEWED FROM THE BASIN RANGES. Chester R. Longwell. **Geol. Soc. Am. Bull.**, Vol 61, No. 5 (May 1950), pp. 413-434. Striking facts are presented concerning sedimentation, diastrophism, and volcanism in the Basin and Range province and a challenge is made of many current theories of orogeny for a consistent explanation of these facts. The author is more concerned with what needs to be explained than with explanations. He suggests that horizontal transfer of great quantities of subcrustal material may serve to explain the problem of orogeny, but finds no convincing explanation for such transfer. All geophysicists will do well to bear in mind this synthesis of knowledge concerning the Basin and Range province. (C.W.W.)

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THE EARTH'S MAGNETISM. A. E. Benfield. **Scientific American**, Vol. 182, No. 6 (June 1950), pp. 20-24. Two theories attempt to account for the primary magnetic field of the earth. P. M. S. Blackett proposed that a magnetic field is produced by a rotating body simply by virtue of its rotation. In supporting this formerly proposed theory, he points out an apparent fixed ratio between the rotation and magnetism of the astronomical bodies with the measurable magnetic fields (of the earth, sun, and star "78 Virginis"). It does not account for the drifting of the poles, the complex shape of the field, and the difference in alignment of the north and south magnetic poles and the axis of the earth's rotation. The Elsasser-Bullard theory assumes that the earth's main field is caused by electric currents in the liquid of the earth's core, which has enough heat in its radioactive content to produce convection currents in the liquid of the core. This theory explains the drifting of the earth's field by eddies in the convection currents near the surface of the core. It does not explain the alternation of the magnetic fields of stars and the polarity of the earth, but is perhaps the most likely theory yet suggested. Possible tests for these two theories are discussed.

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THE GREAT METEOR OF 1947. Otto Struve. **Scientific American**, Vol. 182, No. 6 (June 1950), pp. 42-43. On Feb. 12, 1947, a small asteroid crashed to earth in the Sikhota-alin Mountains of Eastern Siberia. The largest of the more than 100 craters, formed over an area of about one square mile, were about 30 to 40 feet deep and as wide as 75 feet. They were produced by masses 30 tons in weight, and 6 feet in diameter. The entire meteor weighed about 1000 tons and had a diameter of about 30 feet. Meteoric iron, from tiny specks to pieces several hundred pounds in weight, were found over an area of several square miles.

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THE JADEITE PROBLEM. Part II. Hatten S. Yoder, Jr. **Am. Jour. Sci.**, Vol. 248, No. 5 (May 1950), pp. 312-334. Experiments in the attempted crystallization of jadeite are reviewed. The structural analysis of jadeite leads to the conclusion that it is a pyroxene with the type structure of diopside. It is suggested that the field of stability probably lies in a low temperature region (below 800° C.), and that volatiles are necessary to promote its formation. Further, it may be dependent on high pressure or may be hydrous. A list of over 100 references is included.

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THE ORGANIZATION OF SEDIMENTARY ROCKS. E. C. Dapples, W. C. Krumbein, L. L. Sloss. **Jour. Sed. Petrology**, Vol. 20, No. 1 (April 1950), pp. 3-20. A proposed classification is designed for rapid determination of sedimentary rocks. It organizes sediments into associated and intergrading groups, establishes a system of nomenclature which permits recognition of the group to which a sediment belongs, provides a system of identification of sediments based upon observable fundamental properties, and builds the identification system as much as possible around simple tests and the use of the binocular microscope in order to permit rapid identification of cuttings, crushed samples, and hand specimens.

THE NOMENCLATURE AND CLASSIFICATION OF SEDIMENTARY ROCKS. John Rodgers. **Am. Jour. Sci.** Vol. 248, No. 5 (May 1950), pp. 297-311. Sedimentary rocks may be classified into purely descriptive and analytical descriptive, purely genetic and operational genetic classifications. No one classification can serve all purposes. Field workers need primarily a purely descriptive classification and laboratory workers an analytical classification. The author suggests that a continuous variable type of classification, expressed entirely by measured parameters instead of rock names, would provide a precise and objective designation of rocks in terms of their properties.

Plastic Maps Present U. S. A. In Three Dimensions

Fig. 1—The master model

Fig. 2.—The plastic relief map

A vivid, three-dimensional perspective may be obtained from a new, full-color Vinylite plastic relief map of the United States. Molded in this strong, washable plastic, the map costs far less than conventional relief maps of plaster, which are fragile, very heavy and usually custom built. From a carefully built-up master model of clay (Fig. 1), a reverse map of plaster is made to serve as a mold. A sheet of Vinylite plastic on which the map has been printed is placed over the mold, then heated and pressed into the mold. In a few seconds the flat plastic sheet becomes a detailed relief map. The mountains and valleys can be seen and felt. The plastic map measures 64 inches wide by 40 inches deep — large enough to be seen from the back of a classroom — but weighs only two and one-quarter pounds. One inch of the map equals 50 miles. The vertical exaggeration, found on all relief maps, is 20 to 1; it emphasizes relief features — peaks and valleys — as do the 11 brilliant colors in which the map is lithographed. A frame of the same durable material as the map itself is grommeted so the map can be hung easily from four small nails (Fig. 2). It is useful in the office or conference room as well as the classroom. Dust and fingerprints can be easily wiped off the map with a damp cloth. Convenient to move and easy to install, the map is delivered in a sturdy carton which serves also as a storage case.

This relief map of the United States is made by Aero Service Corporation, 236 E. Courtland St., Philadelphia 20, Pa. The retail price is $37.50.

Ohio Coal Geology Laboratory Dedicated

COLUMBUS, O., May 20 — Simple ceremonies marked the formal opening on May 20 of the U. S. Geological Survey's new Coal Geology Laboratory, located in Orton Hall on the campus of the Ohio State University, Columbus, Ohio.

Of the few laboratories in the world designed to carry on coal research related to geology, the Columbus laboratory is one of the most completely equipped. Space for the laboratory was provided and remodeled by the Ohio State University to accomodate scientific equipment and the personnel, which are provided by the U. S. Geological Survey.

The dedication of the laboratory was attended by members of the Ohio State University, Battelle Memorial Institute, Geological Survey of Ohio, U. S. Geological Survey, and coal geologists and technologists from many parts of the eastern United States.

The laboratory is intended to advance the U. S. Geological Survey's diversified national program for the study of coal, both through original fundamental research on coal and through the investigation of problems encountered by Geological Survey parties working on coal in the field. Emphasis will be given also to basic problems, such as the classification of coal, the nature of the fossil plants that make up coal, and factors of decay that influence coal formation.

Studies to be undertaken at the Coal Geology Laboratory have numerous practical applications, Survey officials pointed out. In mapping coal beds, and in determining coal reserves, for example, geologists and engineers must know exactly how far each coal bed extends, and must be certain not to confuse one coal bed with another occurring in the same sequence of rocks. The use of plant microfossils, such as spores and pollen grains, is of increasing importance in providing clues to the identification of coal beds, and thus aids directly in the calculation of coal reserves.

Similarly, the plants that make up coal may be quite different in their internal composition, and may alter differently during the processes of partial decay and chemical change that attend coal formation. These diverse characteristics may explain certain differences in the chemical analyses and utilization properties of coal. If a geologic classification of coal according to the type of plant material it contains can be formulated through study in the new laboratory, the field search for coal suitable for different purposes will be greatly facilitated.

Floods Threaten Pacific Northwest

WASHINGTON, May 10 — Above normal snow accumulations in the Pacific Northwest threaten dangerous floods in the event of sudden and prolonged warm weather, according to the April issue of the Geological Survey's **Water Resources Review.**

Most of the mountain streams in the Pacific Northwest have not yet begun to rise. However, because of the high water content of the snowpack, the total volume of the spring runoff is expected to be large. A gradual, orderly snow melt will result in a long but not unduly high spring peak. But prolonged high temperatures, especially if accompanied by rainfall, may cause damaging floods.

The situation on the Kootenai River in northern Idaho is critical, and flood warnings have been issued.

"Major floods have already occurred in the North Central States and in Manitoba and Ontario," it was pointed out. "Red River of the North at the international boundary was reported to have reached the highest stage since 1826, and peak discharge of the Missouri River at Sioux City was greater than in 1943."

TEACHING THE EARTH SCIENCES IN THE SECONDARY SCHOOLS

[PART TWO OF A THREE PART REPORT]

JEROME M. EISENBERG

The following report is based upon the papers and discussion presented at the Conference on the Teaching of the Earth Sciences in the Secondary Schools, sponsored by the Earth Science Institute, and held at Boston University, March 17-18, 1950. The discussion was recorded by Miss E. Louise Jewell. Both the papers and discussion have been edited and condensed in part by the Editor in order that we may present the entire report.

Principal participants in Part Two of the Conference report were:

C. W. Wolfe, Chairman of the Conference, Boston University, Boston, Mass.

John S. Barss, Phillips Academy, Andover, Mass.

Robert H. Carleton, National Science Teachers Association, Washington, D. C.

David M. Delo, American Geological Institute, Washington, D. C.

C. S. Hurlbut, Jr., Harvard University, Cambridge, Mass.

Arthur Montgomery, Harvard University, Cambridge, Mass.

Donald B. Stone, Mont Pleasant High School, Schenectady, N. Y.

Hugh Templeton, New York State Education Dept., Albany, N. Y.

George Wilson, Quincy High School, Quincy, Mass.

ORGANIZATIONAL WORK IN EARTH SCIENCE EDUCATION

THE PLACE OF THE COLLEGE AND LARGE MUSEUM IN EARTH SCIENCE EDUCATION

By C. S. HURLBUT, JR.
Harvard University

There are two different ways of teaching in a museum: (1) by exhibits and (2) in classes. As far as possible the material covered in classes should tie in with exhibits and these in turn with things with which the children are familiar; for example, an exhibit of andalusite with some spark plugs made from it, or asbestos fibers in the matrix with fabricated products such as cloth, insulating material and shingles.

Many museums illustrate the uses of natural substances by placing mineral fragments against natural backgrounds. To illustrate the production of iron a blast furnace may be shown with a ribbon leading from it to the drawing of an iron mine and a specimen of iron ore; another ribbon to a coal mine and a chunk of coal; and a third ribbon to a limestone quarry and specimen of the rock. In general, the closer an exhibit can be correlated with substances encountered in every-day experiences, the greater appeal it will have for the teen-aged child.

Some museums have exhibits of minerals in their natural surroundings, which appeal to the high school age. The New York State Museum in Albany has a large exhibit of this type showing fluorite crystals projecting into a cavity as they were found in place. Other exhibits of caves from the mining districts of Missouri with crystals of calcite, dolomite, galena, sphalerite and chalcopyrite show the relations of these minerals to one another as they formed.

Another thing that science museums can do it is to have things that "go", for they bring people back over and over again. I hope that the Boston Museum of Science will prove to be of this type. For example, in the present temporary exhibits a Geiger counter can be moved over a case of minerals and the radioactive specimens located unerringly. In museums with small rooms there can be exhibits which, on pushing a button, are explained by a recorded voice. At the Academy of Natural Sciences in Philadelphia there is an excellent exhibit of fluorescent minerals, in which this device is employed. A voice tells you what you are going to see, what you are seeing, and what you saw.

This museum might serve as a model for other museums in the teaching of earth science. Its system of teaching came about only after considerable research in determining what science was taught in the school curriculum and how it could be supplemented. Exhibits were arranged in several branches of science and classes were organized which used these exhibits as demonstrations. Five different classes are now conducted regularly in earth science, and pupils are brought to the museum from elementary and junior high schools. Instructors, supplied by the museum, talk with them in a classroom and, with the use of movies, models and specimens, teach them some of the basic concepts of the geological sciences. After about twenty minutes in the classroom they are taken into the museum proper, where the instructor shows them more specimens dealing with the same subject. Some groups come back to the museum about every three or four weeks to study different subjects.

Although the Harvard University Museum is a professional museum, not geared to the secondary school level, we do some work in geologic education. Hardly a day goes by without some one coming in or writing for information. Specimens arrive, too, for identification. We have a "meteorite" about every two weeks, or about twenty-five a year, but not one real one has come in during the twenty years I have been at Harvard. We have some specimens which are too large to put on the floor, so we made a rock garden with them in the Museum yard. A teacher in a Cambridge school came in to ask about the wonderful "dump" from which the children had been collecting. She had about ten youngsters with her, and each had with him his specimens collected from the "dump".

Harvard is fortunate in having duplicate mineral specimens, enough to be able to give away many teaching collections. Collections of fine specimens are loaned to high school and other teaching museums in New England, and in this way we indirectly contribute to earth science education. Harvard has a responsibility in the field of geologic education, although perhaps it does not recognize it; that of the training of earth scientists to teach at the high school level.

Earth Science Education and the American Geological Institute

by DAVID M. DELO
American Geological Institute

The Earth Science Institute is to be congratulated on planning this Conference. I am delighted to participate in it, representing the American Geological Institute, which is a brand-new organization. The A. G. I. grew out of a six-year period of discussion in professional geology, beginning back in 1942. This finally resulted in the A. G. I., which is to geology what the American Institute of Physics is to physics. Its membership is comprised of the national geological societies, having a total membership of about ten thousand, crossing out any duplication. None of the societies have sacrificed their individual independence or freedom of action. The A. G. I. is set up to do those things which can best be done by cooperative action. We are an agency of the National Academy of Sciences; and the National Research

Council has given us headquarters in the N. R. C. building in Washington.

The organization of the A. G. I. provides for an education committee, and that committee has come forward with a program that I want to describe to you very briefly. It has been approved by the Board of Directors, composed of members from each of the eleven societies which make up the organization. It has four points:

a) The training of professional geologists.

b) the utilization of geological material in general education at the college level.

c) The utilization of geological material in the curricula of junior and senior high schools.

d) the role of geological material in the education of potential teachers in fields other than geology, and as supplementary material in the teaching of these fields; and the methodology of teaching geology, particularly at the more elementary levels.

We can not, because of limited staff and resources, carry on local programs in any sense. We are delighted to encourage programs such as the Earth Science Institute is holding here today. We want to cooperate with state geologists, with local geological and other societies, and with science teachers and their organizations in particular.

The A. G. I. is publishing within the near future a catalogue of all the geological guidebooks which we have been able to locate. We are also bringing out a bibliography of relatively nontechnical books for non-specialists, like the "Rock Book", up to the level of elementary texts. The list covers not only geology, **per se,** but earth science as a whole. It is available for teachers of science in senior and junior high schools who are looking for references which the children can read and understand. We feel that the A. G. I. can assist in planning programs, can work with regional and national organizations, and can in general serve as a sort of center for dissemination of information along these lines.

The National Science Teachers Association and Earth Science Education

by ROBERT H. CARLETON
National Science Teachers Association

The National Science Teachers Association is a voluntary organization of over 5000 members: teachers and others interested in science education at all levels of instruction and in all fields of special interest. At the college level the principal appeal is to teacher training and those concerned with science in programs of general education.

The Headquarters of the N. S. T. A. are in Washington, D. C., where the National Education Association provides office space and facilities and thus far a sizeable grant-in-aid each year. The N. S. T. A. has nearly 50 affiliated groups of science teachers organized on a local, state, regional, or national basis. In addition, N. S. T. A. has effective working relations with many other groups, such as the American Chemical Society, the American Geological Institute, and so on. In all, contacts are thus provided with five to fifteen thousand or more science teachers.

The N. S. T. A. has at the moment three chief media for reaching these science teachers: the journal of the Association, our packets of science information, and a series of publications giving practical ideas and suggestions for science teaching today.

The journal of the N. S. T. A., **The Science Teacher,** has only recently become the property of the Association and we are now on the outlook for manuscripts for articles. We would welcome some from members of the Earth Science Institute — there is need, for example, for practical articles telling a fourth grade teacher how to take a group on a field trip within easy reach of the school; suggesting to the ninth grade teachers of general science how to teach a unit on one or another aspect of geology; describing the construction of teaching aids and models relating to various phases of earth science.

These suggestions are offered in the belief that the best way of promoting more and better teaching of earth science is through the existing science curriculum and the direction in which it seems to be moving. I do not believe that it is moving toward specialized courses in earth science as such. On the contrary, I believe that it is moving away from water-tight compartments and toward greater generalization. Perhaps your job is to help the chemistry teacher, for example, introduce more earth science into the chemistry course. and so for the relations of earth science and biology, physics, and general science. The N. S. T. A. can and will help by opening the pages of its journal to such articles.

However this is not to say that there is no place for specialized courses at the secondary level. I am confident that science teachers recognize two problems as of about equal importance today: (1) the need for more effective and more functional science education for every pupil from grade one on; (2) the need for better methods of discovering students who are talented in science and for stepping up the level and quality of instruction for these talented people.

The second N. S. T. A. service to teachers — packets of science information — is nearing the end of its third year. Recognizing that it is a big problem for teachers to keep up with the cutting edge of science, we have been tapping many sources of free supplementary teaching materials, such as booklets, pamphlets, charts, and samples of products. Coming chiefly from scientific industries, these materials are reviewed by an Evaluation Committee and those which are approved for distribution are assembled into packets and sent to N. S. T. A. members about four times a year. To date 12 packets and nearly three-quarters of a million copies of some eighty titles have been distributed. And the earth sciences have not been neglected. Examples of literature from this area sent out in the packets include stories from the petroleum industry, mining, and reprints of an article on "Careers in Geology." There is room — and need — for more packet material in these fiields: and you can help by bringing the N. S. T. A. packet service to the attention of industries growing out of the earth sciences and their applications.

We are just launching our series of bulletins devoted to **Science Teaching Today.** With emphasis on the practical and "how to do it" type of material, booklets in the series will offer suggestions and ideas for teachers at all levels of instruction and in all fields of science. And here is where we would welcome a lot of help. There is room for extensive collaboration in the preparation, production, and promotion of these booklets. Perhaps some of you have classroom-tested units in earth science which could be offered as a professional contribution for distribution through the N. S. T. A. Perhaps the N. S. T. A. and the Earth Science Institute could collaborate in the production of a series of teaching guides. A unit on "Teaching Soil Conservation," for example, might tie together principles from many fields of science — and perhaps the related principles of physics or chemistry would stick in the pupil's mind better by such a problem approach than if we teach the principles **per se** and point out their applications.

In conclusion, I think we will agree that fundamentally the greatest contribution science teaching can make for **all** the pupils lies in its methods and its attitudes. If so, I don't know a better place to get the "feel" of science — that is, science as methods and attitudes — than in the story of earth science, the science of earth, water, weather, and sky.

Secondary Earth Science Education Through The Earth Science Institute

by C. W. WOLFE
Earth Science Institute

The Earth Science Institute has been the only organization as far as membership is concerned, whose interest is primarily in earth science education. It was organized to spread interest in and knowledge of earth science among people of all ages and all walks of life. The Conference today is an outcome of the purpose of the Institute. We hope that in the future other types of work in earth science education can be done.

The headquarters of the Institute are at present in the home of the Executive Secretary, in Revere, Mass. We hope that in the future a vital Earth Science Institute building may be built somewhere — in Boston, or anywhere it may seem best. Our education work requires a home from which such things as visual aid materials and teachers' programs might be made available; a building in which exhibits would be present for people to learn more about things at the level of which Dr. Hurlbut spoke. This is part of the dream of the Earth Science Institute: to make earth science a living subject.

At present, service to members includes a library of over 600 volumes on all phases of earth science, which may be tapped by writing to the Executive Secretary.

The Earth Science Digest, sent to all members, includes short articles on interesting aspects of geology as well as a digest section with summaries of various articles of worth in geology that have appeared in other periodicals in recent months.

The Earth Science Institute is now in the process of sponsoring a series of booklets on various subjects in earth science which will be published as Special Publications. "The Cave Book" and "A Glossary of Mineral Species" will probably be the first two titles to be issued. The Institute has a projected service idea of making available to teachers, clubs, and the general public, a series of relatively non-technical guide books for field trips. We hope to put out in cooperation with the National Science Teachers Association a number of study pamphlets such as one on running water, suggesting what the teacher can use as background material, what visual aids are available, etc. We hope to do these things as soon as time and finances permit. It is hoped that we will have available visual aid units such as those described by Miss Waterman of the Children's Museum: collections of minerals, rocks, fossils, and other types of geological material.

The total purpose of our Institute is to make earth science intelligible, interesting, and worthwhile to everyone. If we can be of service to you at any time by giving information or in any other way, we will be only too glad to hear from you.

[End of the March 17th session]

MARCH 18, 1950

MECHANICS OF EARTH SCIENCE EDUCATION

The Earth Science Curriculum In New York State

by DONALD B. STONE
Mont Pleasant High School, Schenectady, N. Y.

Earth Science, by that name, has been taught in the secondary schools of New York State only since 1939. However, its predecessor Physical Geography or Physiography as it was also known, was a part of the curriculum for a great many years, and until shortly after the first World War it was a popular high school subject not only in New York State, but throughout the country. With the advent of General Science some of the teaching material of Physical Geography became absorbed in this subject, and there was a resultant decline in Physical Geography as a part of the curriculum.

Even though the philosophy and objectives of education have undergone considerable change during the past quarter century, the study of Physical Geography, now called Earth Science, has remained in the New York State curriculum because of its recognized value in contributing to the general objectives of education.

The committee that was appointed to revise the Physical Geography syllabus considered integrating the subject matter with the other sciences, but was of the opinion that there is justification for offering a one-year course in Physical Geography. The term "Earth Science" was agreed upon as being more appropriate than "Physical Geography" since the outline, as developed by the committee, included materials not commonly found in Physical Geography courses. The course in Earth Science as now taught is a one-year subject recommended for the eleventh and twelfth years. It assumes that the pupil has had General Science in the lower grades, and certain topics in Earth Science that are also treated in General Science have a different emphasis.

The Earth Science course is divided into four main units, each unit proposing definite problems and activities. The first term, composed of two units, is devoted entirely to the field of Geology, both physical and historical. Throughout the teaching of these units the relation of the geological processes to man are included. Cause and effect relationships and logical sequences of events are emphasized. For example, the first unit is concerned with the action of external and internal forces which are changing the earth. The second unit aims to show that the changes, which have been studied in the first unit as now taking place, have also gone on in the past. The second term begins with the study of the earth in its relation to the other bodies of the universe, and attempts to give the pupil some understanding of the nature of these heavenly bodies and at the same time enable him to appreciate the vastness of the universe. The course concludes with a study of the factors that are basic to an understanding of the daily weather changes, as well as of those that control climate.

The four units of the course are so arranged that the first and second term's work deal with sufficiently different topics that the work may be taken as parallel courses in the **same** half-year, if the pupil's program will be benefited. For its cultural values it sometimes is advisable to accept a single term's work in this subject in rounding out a course of study.

The syllabus committee mentioned before further believed that here would be a course of study that offered a wealth of information, both from a practical and cultural point of view as well as one of permanent value. Its content relates to the pupil's every day life and surroundings. This gives reality and concreteness to the work because the pupil's own observations and experiences are utilized. For this reason much of the syllabus material has been drawn from the general principles of the geological sciences, and some from astronomy and meteorology. The basic principles of these sciences are of particular value and interest to a high school pupil. As mentioned before general science is the only prerequisite. A knowledge of advanced high school mathematics is not necessary for a pupil to appreciate and understand the nature of his physical world as presented in our Earth Science outline. The course provides a richness of material for all pupils in general.

The laboratory and field work is an important part of Earth Science. New York State requires a minimum of 30 laboratory exercises. In many schools the pupils are equipped with individual sets of minerals and rocks which they can handle and test for themselves. Topographic maps are used profusely as laboratory exrecsies in the study of physiographic forms. The reading of weather instruments (some of which can be made in the school shop) and the constructing of weather maps help to develop an understanding of the ways of the weather.

GROWTH OF EARTH SCIENCE

The registration in Earth Science has never been large as compared to the other high school sciences, although in the school in which I teach it has always **exceeded** that of any of the other sciences. However, during the past four years the subject has shown a **four-fold** increase in New York State as evidenced by the number of Regents Examination papers written in the subject during this period. To quote Mr. Hugh Templeton, New York State Supervisor of Science, in his Science Letter 4 of March 1949: "There are probably several reasons contributing to this reversal of a previous trend. Many teachers were trained in meteorology during the war and have discovered its worth and interest. Geology is an uncrowded occupational field and most evidence indicates an expansion in the field of meteorology. Earth Science is a valuable course which concerns itself with immediate experiences of more people than any of the other high school sciences except Biology. Unfortunately, fewer science teachers are prepared in this area than in the other three major science areas."

In my opinion the greatest factor responsible for the comparatively low enrollment in secondary school Earth Science has been the lack of adequately trained teachers in this field. In New York State it has been common practice to draft teachers from the other sciences and sometimes from other fields of study, to teach one or two classes of Earth Science even though they did not have the necessary training or interest to do a finished job. Results have often been poor and in many cases the subject has been dropped from the curriculum. Few geology majors enter the field of secondary education and often those who do are unable to adapt their specialized training to high school level. From what ranks then are we to recruit our Earth Science teachers? There is a real need for the institution of an adequate Earth Science course to supplement other science courses in teacher training and liberal arts colleges, and fortunately some institutions have recently inaugurated such a course.

EARTH SCIENCE FOR NINTH YEAR PUPILS

During the school year of 1948-49 one high school experimented in giving Earth Science to selected ninth year pupils in place of the usual general science course. It was felt that if this experiment proved successful it would enable science-talented pupils to complete a four year sequence in the advanced high school sciences. There was nothing to prevent the experiment being made with any of the advanced sciences, but it was believed that Earth Science was the best choice.

The course is being continued this year on the same basis. Fifteen other schools are also giving Earth Science to selected ninth year pupils this year, and others are planning to inaugurate the course next year.

However, there is no feeling on the part of the State Education Department that Earth Science in general should be reduced to the ninth year level. This is simply a step towards giving more of the advanced sciences to specially talented pupils.

DISTRIBUTION BY GRADE AND CURRICULUM

It was stated earlier that the Earth Science Syllabus was planned primarily as an eleventh and twelfth year subject. However it need not be confined to this level and statistics in New York State show that the enrollment has been widely distributed over all three Senior High School grades: In September 1948 the enrollment, reading from highest to lowest was as follows:

11th grade	43%
12th grade	32
10th grade	22
9th grade	3

In September 1949 with an increase in ninth grade enrollment as previously described, the picture was as follows:

11th grade	35%
12th grade	31
10th grade	19
9th grade	14

In my own school, which is a three year Senior High School, the greatest percentage of Earth Science pupils are in the tenth year, followed by the twelfth and eleventh years respectively.

Earth Science is an elective subject and is available to pupils in all curriculums. Because of its cultural value, and widespread appeal it, if properly taught, attracts pupils of varying levels of intelligence from the highest to the lowest. This presents a definite problem to the teacher. Our syllabus has been designed to meet individual differences of pupils. Suggested problems for discussion and also the activities show a wide range of difficulty. Certain portions of the syllabus are indicated as optional. In my own case I have kept the course on a high level with a lower standard of achievement accepted for pupils of lesser ability. It so happens that at present 82% of my pupils are enrolled in the College Preparatory course, but this has not always been the case. In schools where the great majority are drawn from non-college preparatory pupils the course must be geared lower with added projects for the better students.

VALUES OF EARTH SCIENCE

The value of this course to pupils of all levels of intelligence has proven itself many times over. In my personal experience it has been a source of great satisfaction to constantly come in contact with former pupils, in all walks of life, who remark: "Earth Science was the best course I had in high school." During the war pupils returned from the armed services to relate that they had chosen certain branches such as meteorology, navigation or map making because of an interest first aroused in their Earth Science course.

There is much justification for Earth Science in the secondary schools. It provides the pupil with an understanding of his natural environment and gives him an enduring interest that often continues for life. Travel becomes more enjoyable and meaningful. An understanding of the physical features of the earth is of frequent practical use in such occupations as forestry, farming, mining, navigation and many others. It further provides a person with a firm foundation for economic, human, and political geography.

I feel fortunate indeed in being an Earth Science teacher in New York State where this subject has never lost its identity, and I profoundly hope that this Conference will bear fruit in the further promotion of secondary school Earth Science in New York as well as all other States.

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3. **Suggested Materials For Teaching Earth Science:** The Science Teachers Bulletin, Fall 1949, 41 Abbotsford Place, Buffalo, N. Y.

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DISCUSSION

Floor: How much time per week is devoted to the study of earth science; i. e. how much recitation and how much laboratory?

Mr. Stone: The course meets daily, five days a week, with one period out of the five devoted to laboratory work. In New York State, however, there is nothing in the state requirements that would hold a teacher to day-by-day procedure. A teacher would be encouraged to use the periods for a whole week for laboratory work if he wanted to do so.

Floor: Have you incorporated any field trips in this study? Also, if you have different lab assignments how do you separate the different abilities of the students for special projects such as you mentioned — how do you differentiate between those of different abilities. If you have definite lab assignments do they all do them?

Mr. Stone: Each pupil is given the same materials and same problems in lab work. The teacher has to use his own judgment. Some will be poor, unable to finish or to do a good job; however, the better ones finish it up immediately and do as good and as complete a job as you would find in any other subject, and I find additional things for them to do — extra projects. I don't mean always making things; often it is writing up things, giving them special assignments to look up some particular subject. The poor students sort of coast along. What I actually do is to lower the passing mark for the poor student who is not able to do as well as others. ,

Floor: Who is teaching the earth science teachers?

Mr. Stone: In my own case, my college major was geology. When I graduated there were no jobs so I turned to the next best thing — teaching. Not many teachers of earth science have been trained for that. I picked out the 25 best earth science teachers in New York State — and when I say best, I mean best by the results of our regent's examination: on the basis of answers to that examination you can tell whether they have been well taught. Of the 25 "best" four are teaching biology and earth science; three are teaching physics and earth science; one is teaching chemistry and earth science; four are teaching chemistry, physics and earth science; two are teaching all four sciences; one is teaching earth science, geology and general science. In most cases, then, they are teaching more than one science; and in looking up the record I find, for example, that the one teaching the four sciences had 18 hours in biology, 8 hours of chemistry, 8 hours of chemistry and 12 hours of geology. This is certainly a well-rounded background. On the other hand, three of these teachers have had no geology at all. The reason for their success is that they are natural-born teachers.

Dr. Delo: In what institutions do these teachers get their training — teachers' colleges or liberal arts colleges?

Mr. Stone: Mostly liberal arts colleges. We are beginning to get teachers having six hours of earth science since some teachers' colleges are adding to their curriculum. The requirements for the Albany State Teachers College, which is a four-year college, include a course in general geology, a course in the geology of New York State, and a course in earth science.

Dr. Wolfe: One thing I would like to know is this: if the student is to get an all-around education because he will teach more than one thing, how is he going to take twelve to eighteen hours of education subjects which he is supposed to have but which probably don't do him a bit of good? I have students here taking geological subjects but they don't have time to take practice teaching, psychology of learning, etc. The question is how are we going to prepare teachers to teach these subjects adequately and also give them education courses?

Floor: I am a physics major who also got into education the way Dr. Stone did; and I have the physicist's attitude towards orientation. We do get the combination of young men coming into the science field, any quantity of them, with as much as eighty hours of science and still having eighteen hours in education. We now require five years in our State, and I cannot understand why we don't have more hours in science.

Dr. Wolfe: Eighty hours would be two-thirds of the entire liberal arts course.

Floor: Many place have varying requirements: from twelve to twenty hours of education.

Dr. Wolfe: I know they do: how can we do both? (i. e. train them adequately in science and still give education courses.)

Floor: In our state we have to relax our requirements to get the people we need. We would rather they had four years work and then go back to summer school for education courses. They will get more out of summer work if they know what they are getting into in the classroom.

Dr. Wolfe: The five year college course is very desirable all down the line. Students just get ready to graduate when they find something of value in education.

Earth Science Education In Quincy, Mass.

by GEORGE WILSON
Quincy High School, Quincy, Mass.

The earth science course in Quincy is given in the 12th grade on an elective basis, competing with other electives including a course in aeronautics, one in radio, and one in practical physics, yet it still maintains 75 to 100 students every year, and has done so for many years. It seems to fill a need. We do stress from the outset the concepts of the universe. I will take just a minute to tell you how we have built it up.

We think of man as one tiny speck of matter in the universe. We think of the stellar system first, with its galaxies and super-galaxies, and we do a little bit of astronomy. Then we come down to the solar system and planets, sun, moon, tides. Here we try to dispel some of the superstitions the young people grow up with, and encourage them to bring the subject into their homes. Then we carry through with geology and so on. Since I have a hobby of minerals, and taught the course until five years ago, we make a particular point in the course of their having specimens to handle. We also make about four weeks' study of the history of the earth: the theories of its origin, paleontology, etc. We go to the gravel pit for one trip — and from there on they hear the story of glaciers; we go into local history in some detail (Quincy granite: how formed, commercial value, etc.). We conclude the course with man's dependency upon geology, the earth, for his existence.

When we started, only three schools were teaching earth science. We are doing, apparently, the same sort of thing as Dr. Stone is doing in New York. I think it is fine and I highly commend it to all of you who are considering it.

Floor: You were giving the course but you are not giving it now. How did you find someone to carry it on?

Mr. Wilson: Dr. Wolfe was responsible for that. The man who is doing it now was my assistant principal and could teach almost anything. He took a course with Dr. Wolfe and he is enjoying the teaching and doing very well with it.

Floor: Again, I would like to raise the question of how much time for field trips.

Mr. Wilson: Field trips are both after school and in school-time. I would say about one every month, as an average. Sometimes we have a museum trip all day on Saturday, and there are shorter trips, around the school, just during the period. The trip to the gravel pit takes one period. We have trips to Nantasket Beach: half for the field trip and half for fun. In short, whenever the occasions occur, we have field trips.

The Approach to Earth Science Education at Phillips Academy

by JOHN S. BARSS
Phillips Academy, Andover, Mass.

Certain points must be borne in mind in considering what I have to say. In the first place, I teach at a school where 100% of the boys plan to go to college. Secondly, the schedule requirements are such that there is neither time nor room for laboratory work, though all students must take a laboratory science, physics or chemistry or biology, in a later year. Many take two of these.

Our Elementary Science, as we call it, is given in the 9th grade. Its syllabus is evidently approximately standard for a course based on earth sciences: the earth considered as an astronomical object (shape, size, motions and neighbors in space), together with certain consequences thereof; the elements of meteorology; the elements of physical geology; and a whiff of historical geology and of the theory of evolution, though the last two are rather in intent than in practice, for we often do not get so far.

We make a particular effort to tell no lies. By this I mean we try to point out that most facts are approximations. Similarly, we avoid saying "This is the cause of things", but rather "This is the current hypothesis; it may be overturned tomorrow". Our whole emphasis is on **how** we know what we do, not on **what** we know.

Why have we chosen the earth sciences as the content of our course? There are many values with which you are all well acquainted, but I should like to emphasize a few. To begin with, the oldest sciences have the simplest origins and so need the least background; and the oldest science of all is certainly astronomy, which is an "earth science" in its beginnings. This means, obviously, that the historical approach should be used as much as possible. Furthermore, the old and simple sciences connect readily with a child's previous experiences, and answer questions likely to be prominent in his mind.

There are various minor gains to be accomplished from the teaching of earth sciences. We cooperate with the mathematics department, for example; I am sure they are grateful. Our boys have their first experience with graphs of a continuous variable with us; they learn about variations, and about ratio and proportion, and the use of formulas. This year I even taught some of them how to solve fractional equations before they met them in algebra.

Incidently, it is a good idea to say, at appropriate points, "this is chemistry", or "this is physics, or biology". The youngsters' eyes pop at the idea of being given some "senior" science, and it ilkewise helps them to form some notion of what these sciences are about and so helps them to make a later choice.

But the major benefit to be derived from the study of the earth sciences is that in no other way can we show, so clearly and simply, how a scientist goes about his business. Primarily, of course, this means the controlled experiment. Unfortunately, I have to talk about this without showing it — as I said at first, we have no laboratory work — but the gas laws, for example, show very easily what is meant by a controlled experiment. We discuss these laws, we graph them, we solve problems involving them; we do everything but the experiments. (And by the way, may I urge the usefulness of simple apparatus, even homemade, so elementary that attention is not distracted to the apparatus from the point it is supposed to prove. It is amazing how much can be taught with a Boy Scout's sunwatch, for instance.) To continue, nothing shows more straightforwardly than geology the value and necessity of careful, exact observation.

Finally, by the application of the historical method we can show very well indeed how hypotheses have been developed, not all at once by one man, but by the efforts of many over a long time, with slow changes to account for new facts brought out by new observations and new experiments, often themselves suggested by the hypothesis in its form at a particular stage. Another example can be found in the controversy between the Neptunists, following Werner, and the Plutonists, with the eventual triumph of the uniformitarian point of view. Another is given by the study of the "drift", from the early opinion that it was rafted across a primeval sea on icebergs, which rocked back and forth under the action of waves and tides when they ran aground, and so caused striations, through the observations of de Saussure and Agassiz on the Continent and in Britain, to the present form of hypothesis of continental ice sheets.

In conclusion, let me repeat what I said earlier: it is not important what facts we teach; what is important is the spirit in which we teach them.

DISCUSSION

Mr. Montgomery: One very vital fact has come out in the discussion so far — particularly this morning: that around 1895 there was a great deal of geology and physical geography taught in the schools, and five or ten years after that there was practically no such course in the schools. According to Mr. Stone and others there has been an increase in geology courses in the schools in the last few years. I think if we can find out why this tremendous drop occurred and why it is beginning to come back a little, we may begin to understand something of importance to this discussion because we are interested in having a little more geology taught in the schools. I have my own ideas but I would like to hear what others have to say about it. It seems to me that one of the reasons is that at that time when geology was taught, it was taught partly because there was a general interest in natural science. There is also a possible correlation with collecting — there were collections all over the place; it was the fashionable thing at the time. That is one factor we cannot do anything about; another factor in the picture is that probably one of the reasons for the drop in geology was that physics and chemistry came in very strong at that time, were very practical, and everybody heard and knew about them and they were taught; but mere geology seemed to lose interest and meaning to the average person. Now we find there is an increase in geology teaching. Perhaps it is because through the war there was a little more realization that geology has a place in our ordinary life. Geology proved itself of great value to the government and armed forces. People heard about it. GI's were interested; some were in meteorology and saw the connection with geology, and so on. This suggests to me one more thing: that perhaps it is up to geologists to do more to share the thing — prove that it has a practical use, meaning, etc. It is up to the geologists to advertise this and if they can do it, it will be taught again in the schools.

Floor: There was a collection of minerals hanging around in my school for thirty years with no labels and no information about them. I found out later that the course in mineralogy (which had been given) was one in which people had to learn the names and classification of minerals. That perhaps was a factor in leading to the elimination of this course. Take chemistry as taught in high schools in 1900: you will find that the content of the course compared to now is entirely different: most of it we don't deal with now. I am very much concerned: the subject is getting bigger and bigger, and we don't know where it is going to stop. We are going to do more and more. The only answer which I can see is to arrange it so that students will have science all the way through school. It will be competing with a lot of other areas. I realize this but feel the science area has its place in the secondary school, and we are going to see geology put in it; — it should be there, but not necessarily under the name geology.

Dr. Stone: I just want to add to that mentioned earlier that physical geography, geology, astronomy, zoology, botany, Latin and Greek were very popular subjects in the early 1900's. One of my assignments on a committee to revise the course of study in New York in 1930 was to write to all the state education departments in the forty-eight states, and to several of the large cities, and ask them to send their course of study in physical geography to us so that we might study them and see what they had to offer. To my amazement I had two replies: one was North

Dakota, and the other was a mid-West state; invariably the answer was "We no longer teach physical geography for it has been put into the new science called general science." So apparently throughout the country, with the development of general science, which began to become prominent about 1912 and grew rapidly from that time on, physical geography — or parts of it, chiefly geography — became part of the general science curriculum. That is the way it is in New York state to some extent; so is physics, chemistry and biology to be found in general science from the first grade on. A different emphasis was put on earth science that it should be reserved for higher grades — 11th or 12th years. Most of it is geology with a little astronomy and meteorology thrown in as part of the physical environment, which is why we call it earth science. As to what has become of it (i. e. geology in public schools) I think that is largely the answer; that lots of institutions feel they give a comparable course in general science.

Floor: I would like to say that was a very fruitful point, that a real geologist in secondary school could do much towards making the subject vital. I happen to be in an independent school, but we do give a course using college textbooks throughout. We find we are able to cooperate with the history department by supplying their American history group on a straight physiographic basis . . . a physical map of the U. S. to start. Consultations later show that they can tie in surface of the ground to events in American history. When we know our European history, especially, we can get out a physical map of the Balkans and begin to explain backgrounds. When they are dealing with events of the first World War I give them the geographical background. In return, when we give examinations in physiography or geomorphology we encourage the use of other languages. We also have extra points for answers in Latin, French, German and Spanish. We think and say we want languages used in this course for extra credit, so we get a little goodwill in that particular department.

We attempt to put these associations into the lives of the boys: for example, where they go summers. We can brief them on what to look for; and frequently they will bring back photographs in return.

Dr. Wolfe: There is one question concerned in this approach which continually confronts college teachers: this is the students who have no basic knowledge on which they can operate in doing problems or doing work that has to be done. A student comes in here to take geology, but you give him a problem and he doesn't know how to go about solving it. It seems to me we have a difficult problem reconciling these necessities, of obtaining a good basic knowledge in our elementary schools so that when a student comes to college or goes out to work he will not only have approaches and attitudes but equipment. Both have got to be done, and both can be done, I think, but it is a very difficult problem.

New Books

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*APPLIED HYDROLOGY.

Ray K. Linsley, Jr., Max A. Kohler and Joseph L. H. Paulhus. 1949. xiv, 689 pp., 329 figs.; $8.50. (McGraw-Hill Book Co., N. Y.). This new text and reference book deals with the factors governing the movement of water in all its phases through the hydrologic cycle. The authors emphasize the fundamental relations involved in hydrologic phenomena and the development of practical techniques for computing and forecasting streamflow, evaporation, snowmelt, etc., and apply these techniques to the solution of flood control, irrigation, drainage, and related problems. The basic data is almost entirely limited to the United States, as are the techniques and problems discussed. The appendix contains a treatment of graphical correlation, and valuable sections on sources of hydrologic and meteorological data, and physical constants, conversion tables, and equivalents. It will prove to be a valuable guide for engineers who wish to master the techniques for correlating data in the solution of hydrologic problems.

*CRYSTALS AND X-RAYS.

Kathleen Lonsdale. 1949. viii, 199 pp., 13 pls., 138 fig., $3.75. (D. Van Nostrand Co., N. Y.). This book is based on a series of public lectures given in London in 1946, and is intended for those who wish to go into the study of X-ray crystallography and those who use X-ray crystallographic methods and want a clearer picture of X-ray equipment and the nature of X-rays and their application. It presupposes a familiarity with advanced mathematics. The historical introduction provides an excellent account of the comparatively recent development of the science of X-ray crystallography. The book treats of the generation and properties of X-rays, the geometry of crystals, X-ray methods of investigation, geometrical structure determination, atomic and electronic distribution determination, and extra-structural studies. The final chapter describes the achievements of X-ray crystallography in the different sciences.

*ELEMENTARY SCIENCE — REVISED.

John S. Barss. 1949. iv, 137 pp., 53 figs. (John S. Barss, Andover, Mass.). We agree with the author in that "the title of this book tells you nothing about what is in it . . .", for it should be titled "Elementary Earth Science — Revised". It is an outstanding presentation of elementary astronomy, meteorology, physical and historical geology for the secondary school student, emphasizing theories and the historical development of the sciences. We recommend it wholeheartedly as an ideal text for a junior high school general science class.

*GEOLOGY APPLIED TO SELENOLOGY. — IV: THE SHRUNKEN MOON.

J. E. Spurr. 1949. x, 207 pp., 36 figs.; $4.00. (Business Press, Lancaster, Pa.). The late author visualized the moon as a spheroid which shrunk from one which was much larger, perhaps with an equatorial diameter between 3000 and 4000 miles. This shrinking started at the time of the moon's capture by the earth. During much of this time, the moon's surface temperature may have been 1000-2000° C. The process of gas-elimination and condensation was accelerated by the capture of the moon by the earth through renewed heating and increased equatorial appression. This study of the past history and evolution of the moon's surface is an excellent example of the application of the inductive method to the study of a science.

*A NEW THEORY OF HUMAN EVOLUTION.

Sir Arthur Keith. 1949. x, 451 pp., 1 fig.; $4.75. The basal idea of the author's "Group Theory" of evolution is that man has evolved from the very beginning as a member of a social group. A large number of these small competing groups favored rapid evolutionary changes. These original groupings were determined by territory, not by kinship. The author believes that the higher primates already had this group division before man's simian ancestor appeared on the earth. This theory, perhaps, may be considered a new rendering of Darwin's theory. In this book the author discusses his new theory of evolution, the major divisions of mankind, the evolutionary role of "race", and the rise of nations. This volume should prove to be stimulating reading for those interested in the sociological aspects of evolution.

REPORT OF THE COMMITTEE ON A TREATISE ON MARINE ECOLOGY AND PALEOECOLOGY. 1948-1949.

Harry S. Ladd, Chairman. 1949. 121 pp., 19 figs.; $1.00. (No. 9, National Research Council, Division of Geology & Geography, Washington 25, D. C.). The current report features articles on the Paleoecology of the Cambrian in Montana and Wyoming by Christina Lochman, and the Paleoecology of the Jurassic Seas in the Western Interior of the United States by Ralph W. Imlay. Other articles are: Current Activities, Recent Publications, Annotated Bibliographies of Marine Ecology and Paleoecology, and Types of Occurrence and Position of Bryozoa in Late Paleozoic Sediments of the Midcontinent.

*INTRODUCTION TO COLLEGE GEOLOGY.

Chauncey D. Holmes. xxii, 429 pp., 312 figs.; $4.00. A well-illustrated introductory text suited for a one-semester course. Following an introduction to the earth, and rocks and minerals, it presents an outline of the geologic history of North America. The concluding chapters deal with rivers, landscapes, groundwater, wind, and petroleum. The principles of rock and mineral identification are discussed in two supplements.

THE DISTRICT OF COLUMBIA — ITS ROCKS AND THEIR GEOLOGIC HISTORY.

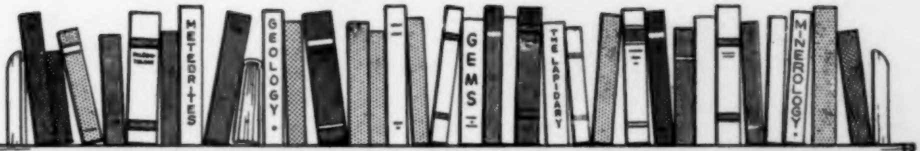
Martha S. Carr. 1950. viii, 59 pp., 7 pls., 23 figs.; $1.25. (U. S. G. S. Bull. 967; Supt. of Documents, Govt. Printing Office, Washington 25, D. C.). The author's purpose is to present a picture of the geology of the District in a form that will serve the teacher, the student, and the layman. This purpose is fulfilled in an admirable way, and this publication is a credit to the Survey, which should be commended on this forward step in geologic education. A condensation of the report may be found on pp. 3-6 of this issue.

FORTHCOMING ARTICLES

A Geologist Visits Europe — Both Sides of the Iron Curtain, by Horace G. Richards.

A Glossary of Mineral Species, by Jerome M. Eisenberg.

Prospecting for Ores by Geochemical Methods, by Jerome M. Eisenberg.



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2. HANDBOOK OF URANIUM MINERALS by Jack DeMent and H. C. Dake, 2nd Edition, 1948. 96 pp., 22 illus. 2.00
3. MANUAL OF MINERALOGY by Edward S. Dana. 15th Edition revised by C. S. Hurlbut, Jr. 1941. 480 pp., 436 illus. 4.50
4. GETTING ACQUAINTED WITH MINERALS by George L. English. 1936. 324 pp., 258 illus. 2.75
5. TEXTBOOK OF MINERALOGY by Edward S. Dana. 4th Edition revised by William E. Ford. 1932. 851 pp., 1089 illus. 6.00
6. HISTORICAL GEOLOGY by Carl O. Dunbar. 1949. 567 pp., 380 illus. 5.00
7. OPTICAL CRYSTALLOGRAPHY by Ernest E. Wahlstrom. 1943. 260 pp., 208 illus. 3.25
8. DANA'S SYSTEM OF MINERALOGY. 7th Edition by Charles Palache, Harry Berman, and Clifford Frondel. Vol. I: Elements, Sulfides, Sulfosalts, Oxides. 1944. 834 pp., 1500 illus. 10.00
9. INDEX FOSSILS OF NORTH AMERICA by Hervey W. Shimer and Robert R. Shrock. 1944. 837 pp., 303 pls. 20.00
10. THE OCEAN by F. D. Ommaney. 1949. 238 pp., 16 illus. 2.00

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